Gulf Freeway Interchange — *E. M. Schiwetz*

The HUMBLE WAY

JULY-AUGUST, 1952

The HUMBLE WAY

July-August, 1952

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Mid-Year Report to Stockholders

Humble stockholders received about the middle of August the following interim report on the Company's operations for the first six months of the year:

Humble's net income in the first half of 1952 decreased as a result of higher operating expenses. Although costs continue to rise as wage rates and prices of materials advance, the price of crude oil realized now under government price ceilings is lower than in 1948.

Production declined sharply from May through July, particularly in Texas, as the demand for crude oil was reduced by refinery strikes throughout the industry. Humble's production and pipe line deliveries were adversely affected by this development, although there were no strikes in the Company's operations. It is anticipated that Humble's crude oil production for the remainder of 1952 will be at a higher rate than in the first six months. Humble's refinery runs continued at a fairly high level.

The Company's drilling operations have been held back by shortages of steel. The steel strike has forced a sharp reduction in drilling and will substantially affect well completions in the last half of the year. Consequently, Humble will not be able to carry out all the drilling and other capital expenditures planned for 1952. Well completions and capital expenditures in the first six months of this year were at a lower rate than during the last half of 1951, although higher than in the first half of that year.

Net income per share of common stock was $2.09 in the first half of 1952. Dividends were $1.14 compared with payments in the first half of 1951 of $1.00 a share on the basis of the new stock.

	1952	1951		
	First Half	First Half	Second Half	Year
FINANCIAL DATA				
Gross Operating Income	$488,753,900	$461,520,300	$489,530,700	$951,051,000
Net Income	74,992,600	89,313,500*	80,167,100*	169,480,600*
Taxes†	35,052,300	38,356,200	46,493,500	84,849,700
Dry Hole Costs	19,294,400	11,300,000	17,981,500	29,281,500
Dividends Paid	40,897,427	35,951,360	44,910,682	80,862,042
Capital Expenditures	85,239,300	70,559,100	88,234,700	158,793,800
Net Income Per Share‡	$2.09	$2.49	$2.23	$4.72
Dividends Per Share‡	$1.14	$1.00	$1.25	$2.25
OPERATING VOLUMES—Barrels Daily				
Net Crude Oil Production	344,600	338,800	358,200	348,200
Crude Oil Refined	245,600	244,300	249,000	246,700
Trunk Line Deliveries	710,500	737,100	746,900	742,000
WELLS DRILLED BY HUMBLE				
Producing	455	380	513	893
Dry	122	109	131	240

The interim financial data are subject to change by audit for the year.
*Includes a nonrecurring profit of $1,613,500 in the first half and of $3,060,000 in the second half of 1951.
†Federal income taxes computed at the rate of 47 per cent for the first half of 1951, 50.75 per cent for the year 1951, and 52 per cent for the first half of 1952.
‡Based on new shares outstanding.

Workover rig on the job in the Friendswood oil field. A workover operation tries to re-establish or increase oil and gas production from a previously drilled hole.

An important part of every workover job is the planning and paper work that has to be done before field work can be started. Successful workover jobs are triumphs of teamwork over trials and tribulations that are likely to beset any particular well.

NEW LIFE FOR OLD WELLS

Workovers may bring dying wells to life, stimulate and increase yield of ailing wells

THE average American, say the actuaries, is growing older. With our normal life span now pushing three-score-and-ten, silver threads are moving in on the gold. Geriatrics, or care of the aged, is winning new prestige among the medical arts.

Much the same thing is happening in the nation's oil industry. The average producing well is growing older, more vulnerable to the onslaughts of time. And workovers, the geriatrics of the oil industry, are taking on a patient load which is the heaviest in history.

Since Drake first scratched paydirt in 1859, nearly a million producing wells have rewarded the risks of America's wildcatters and developers. Of these wells, about half (an estimated 447,000 at the end of last year) are still alive and kicking, but each year more and more of them are popping up on the industry's sick list.

Some of these wells, of course, turn up their toes and die for good—usually from a deficiency of oil. But many another can be saved, its vigor restored and its life prolonged. All it may need is a workover job.

A workover, as defined by oilmen, is any operation which tries to re-establish or increase oil and gas production from a previously drilled hole. Sometimes the workover may involve only repair work to underground equipment. On another well it may be for the purpose of tapping another pay zone, either higher or lower than the original producing section. Or, finally, it may aim at squeezing off water or gas intrusion.

One Humble engineer puts it this way: "We look upon wells as a set of valves which release oil from huge underground storage tanks. A workover cleans and repairs these valves so they will work better. That way we get a maximum of the economically recoverable oil."

Workovers have given thousands of America's wells a new lease on life. So-called stripper wells, for instance, yield only a smidgin of oil—say, one

to eight barrels a day. (The average output for *all* U. S. wells last year was only 13.7 barrels a day). Without workovers, many of these wells would have to be abandoned. With workovers, they can often be stimulated and their daily yield upped ten or more times.

A good deal? Oilmen say yes, indeed. Good for the industry, good for the landowners, and good for the nation.

There's nothing accidental, nothing hit-or-miss, about the industry's long string of workover successes. Summed up, it might be called a triumph of teamwork over the trials and tribulations which are likely to beset any oil well.

At the wellhead stands the lease pumper, almost always the first man to spot an ailing well, and to him belongs no small part of the credit for every successful workover. He keeps his finger on the pulse of all the wells under his supervision (usually a dozen or more), and his reports provide the basic data for every correct diagnosis. To a large extent, the fate of each well rests in his hands.

Backing up the pumper are the other members of the team: the farm boss, with his important supervisory responsibilities; the district superintendent, assisted by his staff of engineers and geologists; the division office personnel; and finally the workover analysis group in the main office.

To the pumper's original data are added pertinent engineering and geologic information, diagnostic opinions, treatment recommendations, and estimates of cost. All this boils down into the final workover plan, the job is performed, and the chain of action which started with the lease pumper is completed.

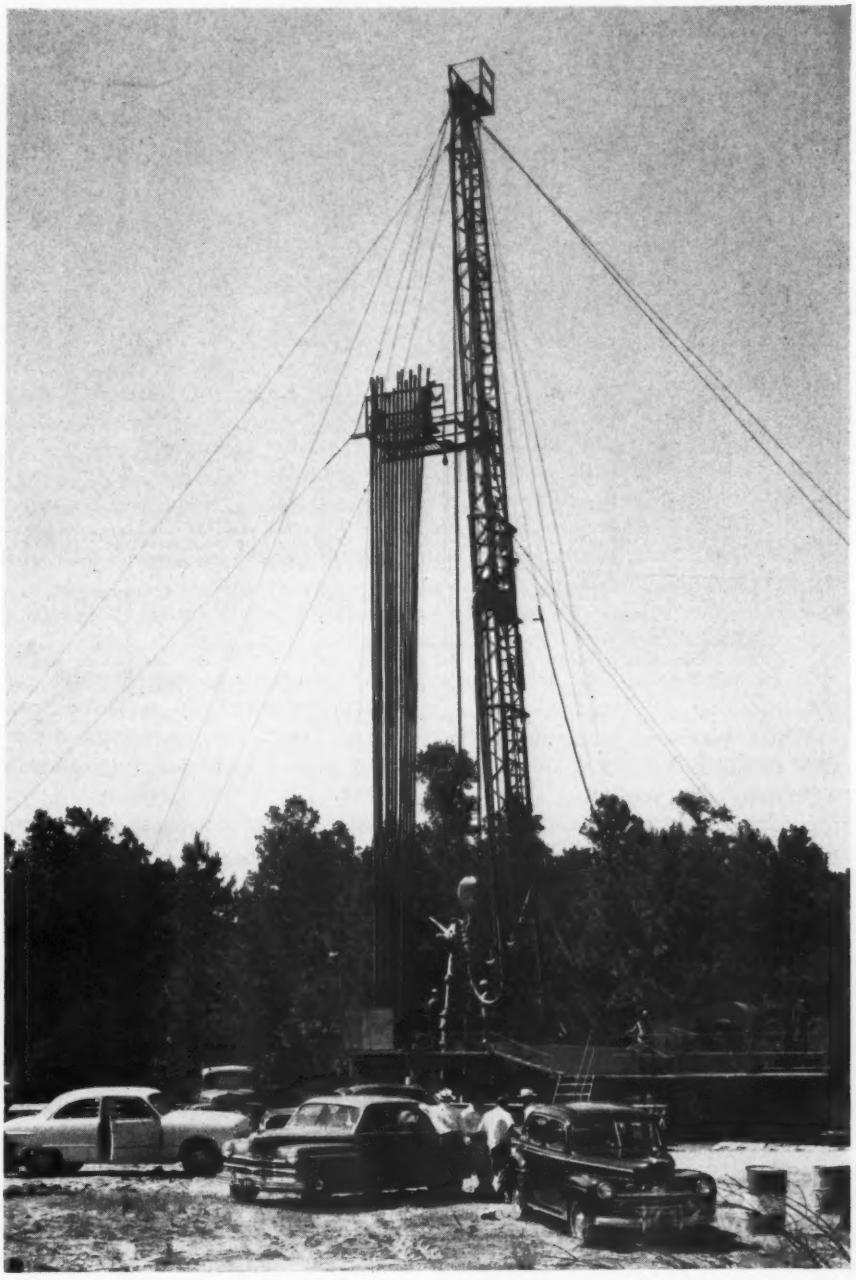
Almost every oil and gas well is worked over at least once during its life. Other wells—those with large reserves as their ace in the hole—have a longer life expectancy and may be worked over 10 to 20 times.

One has only to look at Humble's workover program of last year to see that perking up sluggish wells has become big business. In 1951, the Company performed 723 workover jobs—a fifth more than during the previous year. The cost: a little more than seven million dollars, or an average of $10,100 a job!

"It was a big year for workovers," an engineer commented, "but the program is still being stepped up. We expect a tenth of the Company's 11,000 wells to be worked over this year. That will be about four times as many as in 1948."

No workover operation is a success unless the patient lives. A remarkable commentary on the ability of those practicing the art is the fact that three out of every four Humble workovers last year were successful. In oil field parlance, the program "paid out."

The matter of pay out—of getting over the break-even hump—bulks large in any workover program, for a company could fast go in the red working over wells at $10,000 a whack only to recover $5000 worth of oil. Last year the average pay out time for Humble's successful workovers was 225 producing days. Individual wells, however, may take much longer. On one workover (not Humble's), an expensive fishing job jacked up the total cost to a whopping $87,000. It



Portable rig works over an ailing well in pine-rimmed glade of the Conroe Field.

Testing temperature of kerosene which, when it reaches the proper temperature, may be mixed with gelling agent in the formation fracturing process known as Hydrafrac.

took 14 months for this well to pay out.

While older wells are most susceptible to functional disorders, younger wells may also require a workover. Sometimes, in fact, a workover job must be performed on a brand new well.

"You may bring in a new well," says an engineer, "and it is a sick baby from the day it is born. In a case like that, the best solution may be to recomplete—in other words, work it over."

Today, generally speaking, more and more new wells are turning out to be sick babies. Why? Well, one big reason is that the industry is now probing formations which would have been passed by as non-commercial a few years ago. These formations often have wafer-thin sands and a high percentage of shale. Or, as in the Spraberry Trend, they may hold the oil in a rock grip almost impossible to break.

Any attempt to draw oil from a marginal sand is an expensive gamble, but three factors have combined to make the try worthwhile. One is today's tremendous demand for oil—far greater than it was at the height of World War II. Another is the price of oil, something which can be decisive in determining whether or not a well (with its inevitable workovers) will pay out. And finally there are today's vastly improved methods for drilling and completing wells.

These same factors have had a bearing on workovers, too. In case after case, they have tilted the scales in favor of both the sick babies and the ailing oldsters. An especially weighty factor has been the development of new completion techniques, many of which are less than 10 years old. To cite a few examples:

Formation fracturing, which uses hydraulic pressure to crack open flow channels for oil, made the transition from theory to practice about four years ago and has since proved itself in hundreds of wells. Eight recent workovers on Humble wells in Pecos County relied on this technique. All eight jobs were successful, with an average potential increase of 40 barrels a day!

New chemical tools, mainly acids, are proving equally effective in breaching blocked-off formations. Take the workover record of mud acid, used to cleanse the face of well bores clogged by drilling fluids. On one Humble well, a mud acid treatment boosted the oil flow from 22 barrels a day to 102. On a gas well, it sent the daily take soaring from four million cubic feet to 14 million cubic feet. A chemical cousin, called a mud clean-out agent, has produced phenomenal results in the Conroe Field. One well went from zero oil to 184 barrels a day!

Nor have perforating guns, another powerful weapon in the workover arsenal, lagged behind. Both types, those firing bullets and those firing shaped charges, are clobbering oil reservoirs with a power undreamed of a few years back. One or two inches beyond the casing used to be considered a good depth of penetration. Now bullets and jets are plowing six or eight inches—sometimes more—back into the formation. Recently developed was a tiny jet model, a derringer among perforating guns, which is small enough to be run through two-inch tubing. This midget gun enables a crew to forego pulling the tubing, thus saving hours of valuable rig time.

Success seems to breed success, and dramatic progress has marked other technical phases of the workover program. Sloughing sand, for instance, once the bane of many a well, is being held at bay by improved methods of gravel-packing. In one field, a well was about to be abandoned. After a workover involving gravel-packing, it yielded 50,000 more barrels of oil. Light portable rigs are also helping save time and money. But it is in the

diagnostic field that some of the greatest advances have been made.

Look at it this way: You have a well bottomed one or two miles underground. It's in poor shape, its production of oil on the ebb. How are you going to diagnose its ailment? You can't take a powerful magnifying glass, look down the bore, see what's wrong, and then prescribe a treatment. You could, of course, prescribe treatment after treatment until you hit upon the right one, but at $10,000 a dose your apothecary bill would run sky-high. You need to be right the first time.

In most cases, as Humble's record shows, the workover technicians—geologists and engineers—*are* right the first time. How do they do it? Well, in the first place, they study the reservoir. Is the trouble inherent with the kind of drive or is it connected with depletion of the reservoir? They study the character of the oil. Is it plugging the formation? They study the producing sand. Is it a type which is conducive to bridging (filling up the hole with sand)? They determine the method of completion. Did the drilling mud damage the formation?

First answers to these questions can usually be worked out in the field. The lease pumper, the man in closest contact with a producing well, can provide many a good clue. To a veteran pumper, each well has a history and a personality all its own. Let a well take on a sickly cast, let it start making gas, water or sand, and the pumper immediately notes the trend in his reports. His is a real responsibility, for often the ultimate correctness of a diagnosis will hinge upon the accuracy of his reports.

The pumper's supervisor, the farm boss, passes the information along to the district office, where engineers and geologists study it and make a preliminary estimate of the situation. Here, at the district level, a workover analysis is prepared. This includes such basic data as the well's complete life history, the objective of the proposed workover, the intended workover procedure, and an economic analysis of the job. The district's proposal is then passed along to the division office, where other workover technicians add their comments and recommendations. The final stop is Humble's main office.

Thus the workover plan moves along from echelon to echelon, with management, engineers and geologists at each level bringing their skill and experience into play. Sound complicated? Well, the whole procedure is often handled by telegraph, with one day's time enough in which to inject new ideas all along the line. Once all the facts are in, approval of a workover job may be forthcoming in 15 minutes.

The cycle of workover responsibility begins in the field. It also ends there. For even with a correct diagnosis and a proper prescription, the outcome of a workover will depend on the efficiency with which a job is done. There may be logs to be run, liners to be cut out. Exactly the right interval in the formation must be selected for treatment. To make the workover an economic success, the field personnel must skillfully and efficiently execute all the many corrective measures.

Although few stop to realize it, workovers have become a key part of the oil industry's conservation program. In the first place, they help keep to a minimum the amount of gas or salt water needed to lift the oil. This means a better utilization of natural reservoir energy, something which may increase ultimate recovery many times. Workovers also help conserve equipment and manpower by reducing the need for expensive mechanical means of lifting the oil.

Shortly after the A-Bomb brought the Pacific campaign to a screeching halt, a reporter from a national magazine sailed into Houston and asked to be shown an oil field that had been drained dry by our thirsty war machine. It was a request Humble was unable to fulfill.

"That kind of production went out with the gusher," the visitor was told. "Produce a well wide open and it'll die an early death. *And you're likely to by-pass forever twice as much oil as you get.*"

That, in the final analysis, is where workovers come in. They're helping to see that no oil is by-passed, that every recoverable drop is surfaced.

Old oil wells can never become fountains of youth. Someday an empty reservoir must cause their inevitable demise. But workovers, the geriatrics of petroleum engineering, are postponing that day. For a time at least, they're bringing new life to old wells.

Perforating gun, made of aluminum pipe, can be placed and fired inside the tubing.

Odometer, above, ticks off footage as gun is lowered into tubing. Below, after gun is fired, stuffing boxes are tightened to be sure pressure does not leak around line.

Geologist points out some of the physical characteristics of a core cut from formation penetrated by the drilling bit. Other samples, tagged and sorted, will be sent to laboratories where tests will be run to provide information for reservoir engineers.

RESERVOIR ENGINEERING

Today's reservoirs get proper care to make sure that maximum recoverable oil will be produced

WHEN the oil industry was young, operators swarmed around each discovery like a high school crowd storming a soda fountain. Speed was the only watchword. Proper well spacing was unheard of, and conservation was unknown. Oil was harvested as if everyone feared that each barrel might be the last. "Git it and git" was the battle cry.

By such tactics, operators unwittingly condemned themselves to bringing up only a small fraction of oil that might have been recovered under wiser production practices. Nowadays they know better. Today's reservoirs get proper care, are nursed along to make sure that the maximum of recoverable oil is produced from them.

Contributing to this happy situation is a relatively new science—the science of *reservoir engineering*.

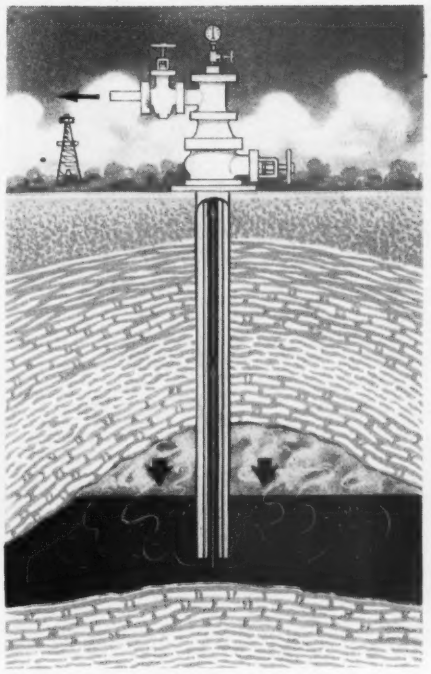
Studies of oil reservoirs and their behavior developed rapidly in the 1930's mostly in the research laboratories of oil companies. Knowledge gained from those studies has been widely applied to production and field problems since World War II. The goal, simply speaking, is to produce more oil in the long run and to produce it more efficiently.

Though specialists in this work are quick to admit there is still much to learn, a good start has been made and progress is steady and encouraging. Ways have been developed to "look" down into a reservoir and evaluate what is found there. Oil company engineers all over the country are busily engaged in gathering reservoir data, analyzing reservoir behavior, verifying analyses, and translating those analyses for management.

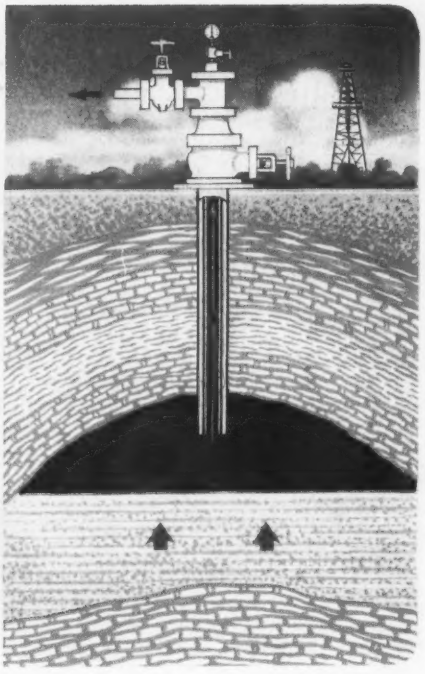
Gathering Reservoir Data

Most reservoir problems deal with future operations in the light of past performance of the reservoir. Naturally, the more information engineers can gather, the better equipped they are to deal with problems and work

Dissolved gas drive depends upon expansion of gas dissolved originally in the oil. As pressure declines, gas is released from solution and forces the oil to the surface. This is the least efficient type of drive, maximum recovery usually being 15 to 30 per cent of the oil in place.



Free gas cap under pressure presses down on the oil and forces it to the surface under gas cap drive. This maintains pressure and retards gas escaping from solution. Recovery of 30 to 80 per cent of the oil in place may be achieved with this type of drive.



Water advances from below to displace oil by water drive. This is the most efficient drive, as water flushes oil from sand more thoroughly than gas. Recovery is usually about 60 to 80 percent of the oil in place.

out suitable solutions. Some say that at least 10 per cent of recoverable oil must be produced from a reservoir before a reliable performance study can be made. Four broad types of information are needed: data on the reservoir rock, the properties of reservoir fluids, a pressure history of the reservoir, and its production history. Any one of these is a considerable task to gather. The engineer needs all four before he can even begin to predict how the reservoir will act or how much oil it may be expected to produce.

For some idea of the scope of such a job, consider how these questions might be answered: How much total producing rock is there in the reservoir? How much pore volume is there in the rock where oil can accumulate? How much oil, gas, and connate water (water mixed with oil and gas) is collected in those pore spaces? How permeable is the rock—that is, how easily and freely can gas and liquids flow from one pore space to another? That question is especially important. It is possible for a reservoir rock to be quite porous and yet not very permeable. If it is to be a good producer, the reservoir should have plenty of connected pore spaces, so the oil can flow to the well bore.

Knowing the rock and its make-up, the engineer needs to determine the physical properties of the gas and fluids contained in the rock. What kind of gas or oil is it? Laboratory studies of samples reveal the answer to that question, and to others. All these answers have a bearing on how much oil the reservoir may be expected to produce, and how easily that oil may be brought to the surface.

As carefully and completely as doctors keep case histories of their patients, reservoir engineers keep records on the oil, gas, and water produced from formations under study. Total volumes of fluids produced are used for problems dealing with the reservoir as a whole. Per-well production data are used for problems dealing with in-

In laboratory, cores get a thorough testing, give reservoir engineers clues as to how the producing reservoir may perform.

Much of a reservoir engineer's time is spent in the realm of mathematics. This "mechanical brain" whips off problems in short order, saving a great deal of staff time.

dividual wells. Other information is helpful, too—information like the productive capacity of each well, its location on the producing structure, and the interval of formation perforated in that well.

The reservoir's pressure history, or at least a reliable trend of average pressures, is a useful tool of the reservoir engineer. For problems dealing with reservoirs as a whole, average pressures are obtained based on all or a selected number of key wells. Per-well pressure data are used in studying the movement of fluids within the reservoir.

Studying Reservoir Behavior

When a reservoir is discovered, fluids in the rock pores are at rest. This equilibrium is disturbed as oil is produced. When the oil moves out, something must take its place—following the old law that "Nature abhors a vacuum."

When a well is opened and fluid moves from the reservoir into the well bore, the pressure in the formation drops. Remaining fluids or gases expand and move toward the well bore. Production depends to a great extent on the type and amount of forces that drive oil through the rock pores to the well bore.

There are basically three different types of reservoir drive mechanisms: dissolved gas drive, water drive, and gas cap drive. Any reservoir may be producing from one or a combination of these.

A *dissolved gas* reservoir might be compared with a bottleful of ordinary soda water. When pressure is released by a producing well, dissolved gas expands and forces some oil into the well bore—just as soda water sometimes bubbles over the top when the cap is pulled off. Pressure falls rapidly in this type of reservoir as fluids are produced, and recovery of oil is usually quite low in respect to total volume in the reservoir. Perhaps 15 to 30 per cent of the original oil in place may be produced. In this case, materials withdrawn are oil and gas, with expanding volumes of oil and gas taking the place of that withdrawn. Almost all of the expansion comes from the liberated gas.

A *water drive* reservoir is one in which water underlies the oil, tending to sustain reservoir pressure, and displacing oil ahead of it. As pressure drops with the oil produced, water moves up into the pore spaces vacated by oil. In studying these reservoirs, engineers are concerned with the total rate of oil and gas production, and how the displacing water may be used most effectively. The rate of water encroachment, as measured by the position of the oil-water contact in the reservoir, is carefully watched.

Recovery of oil from a water drive reservoir is usually high, ranging up to 80 per cent of the original oil in place. In some fields, water may be supplied artificially by *water-flooding*, or pumping more water down into the reservoir to drive more oil out.

From a total recovery standpoint, a reservoir with *gas cap* drive ranges somewhere between the dissolved gas and water drive types. Recovery from the gas cap type ranges from 30 to 80 per cent of the oil originally in place, depending upon the size of the gas cap, how well the gas can be conserved, and other factors. In this type of reservoir, engineers are concerned most with conserving the volume of gas in the cap.

Verifying and Interpreting Analyses

Perhaps the most important phase of any reservoir analysis is its verification. The analyst must satisfy himself, as well as others, that his work properly reflects the actual reservoir performance. Improper interpretations can cause all sorts of trouble and expense. An operating program might be adopted, for example, which would reduce rather than improve the efficiency of reservoir behavior. Such an

Preparing to run temperature survey on a well for reservoir engineering studies.

analysis might lead to heavy expenditures which would go for naught and have little salvage value. Not only must the analyst try firmly to establish an evaluation of the reservoir; he must be as well acquainted as possible with the limitations and uncertainties of his study.

Local and regional comparisons can be made to establish the reliability of the reservoir analyses. Region comparisons are made to determine if the reservoir performs in accord with the performance of other reservoirs in the general area and in accord with general geological features known to exist in the area. Local comparisons concern the individual well performance and involve such things as checking movements of the gas cap and water zone to check calculated gas cap expansion or shrinkage and water influx.

After the reservoir engineer has verified his findings as closely as possible, it is his next duty to interpret them and make recommendations to management. These important interpretations are used as a basis to:

1. Determine the MER, or maximum efficient rate, at which a reservoir should be produced.
2. Evaluate the economic payout of such operations as pressure maintenance.
3. Plan and evaluate workover programs.
4. Plan and evaluate artificial lift programs as reservoir pressure is reduced.

All four of the above considerations show that money plays a strong part in the work of reservoir engineering. For the reservoir engineer, economic analyses are as much a part of the reservoir study as the performance calculations, and merit the same careful treatment. In addition, the reservoir analyst must keep abreast of the legal aspects of oil production and must be completely familiar with rules set up by regulatory bodies.

Machine Calculators

Much of a reservoir engineer's working day is spent in the realm of mathematics, and his life on the job at times may seem like one equation after another. The study of just one reservoir may call for a mountainous mass of equations and figures, and the task of working them out is multiplied by as many reservoirs as may be under study. Until recent years, the engineer had to work out his equations entirely by slow and tedious hand methods. Fortunately, he can now rely for help on machine computers that have been developed and put into use largely since World War II.

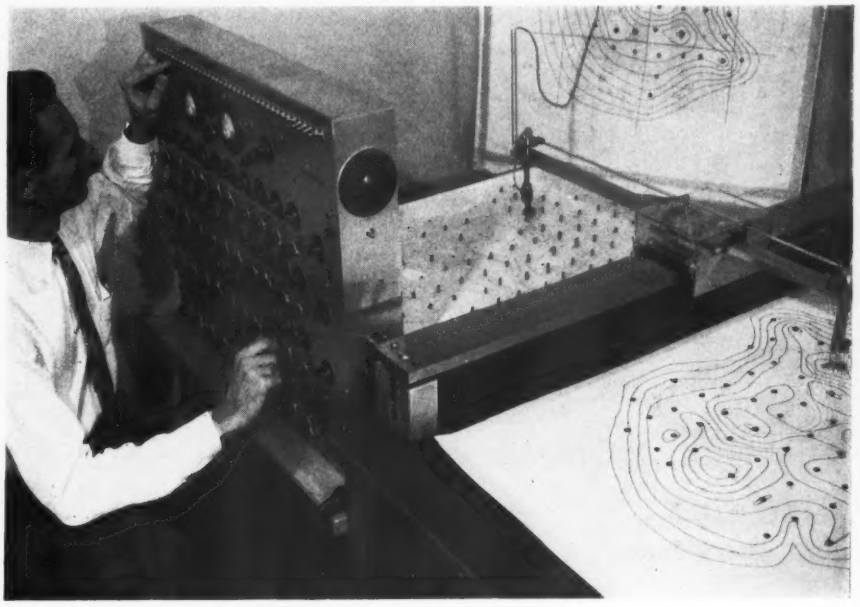
These machines are marvels of electricity and electronics. They almost think for their operators. In a few minutes, they whip off problems that would take a man a week of toil with pencil and paper. Machines like this literally "remember" numbers by storing them aside and using them later. They work only with digits, but problems in algebra or calculus can be solved by substituting numbers for letters and symbols.

One such machine, called a digital computer, works out in short order such complicated problems as determining how much oil can be obtained by changing the conditions of separating oil, gas, and water at the surface. It can also be used to calculate the behavior of fluids flowing through rocks, or any other of practically endless problems dealing with reservoir studies.

Another machine does the almost incredible job of duplicating at the surface what goes on below in the oil reservoir. This is called an *analog computer*. It uses electric current which is analogous to the flow of fluid in the reservoir. The electric system acts like the reservoir acts, so measurements can be made on the machine and correlated with what would happen under a given set of conditions in the reservoir.

The *potentiometric model,* another form of analog computer, lets the engineer know where the dry gas is going in a study of gas cycling operations . . . or where the water is going when the engineer studies a water flooding project.

Improvements, refinements, and new inventions are adding all the time to the scope and usefulness of machines in reservoir engineering. Undoubtedly, they are ticketed for even greater measures of usefulness in the years ahead.



Using this device, whose electric system acts like the reservoir acts, measurements can be made and checked with what may occur in reservoir under given conditions.

Conclusion

Although reservoir engineering is a new science and there is still room for speculation on what the subject covers and how it enters into production problems, it has had wide application in the past and has won acceptance in the industry as an essential part of producing operations. As the work further proves its worth, management relies more and more upon it. The work is expanded; new techniques are brought in; old techniques are improved. The benefits are being shared by oil companies, by royalty owners, by oil consumers, and by a nation whose economy and security depend in large measure upon conserving and improving the recovery of an important natural resource.

San Antonio's skyline forms an interesting background for one of the divided overpasses on the city's new expressway.

TEXAS BUILDS SUPERHIGHWAYS

Super roads, bigger and safer, help solve problems arising from city growth and constantly increasing flow of traffic

LET one of Julius Caesar's legionnaires return and watch traffic flowing along the Gulf Freeway between Houston and Galveston and his comment might be: "Very nice . . . very nice. Reminds me of our Appian Way. You know about the famous Roman Highway, of course. The first section of it was built about 300 B.C. . . . a little before my time, but I can still see the farmers' carts crawling along and the charioteers charging past at breakneck speed."

"A naive fellow," you would probably say to yourself. "He's not as much impressed with this magnificent expressway as we are."

But then you would recall that the Romans *were* great road builders. And the Appian Way, which ran southward from Rome to lower Italy, was an outstanding highway project. It was started by a toga-clad engineer named Appius Claudius Caecus in 312 B.C. After more than 2,000 years, some of the original route and several of its bridges are still in use. The fact that the great stone road was only 14 feet wide and was 68 years a-building takes nothing from the luster of the achievement.

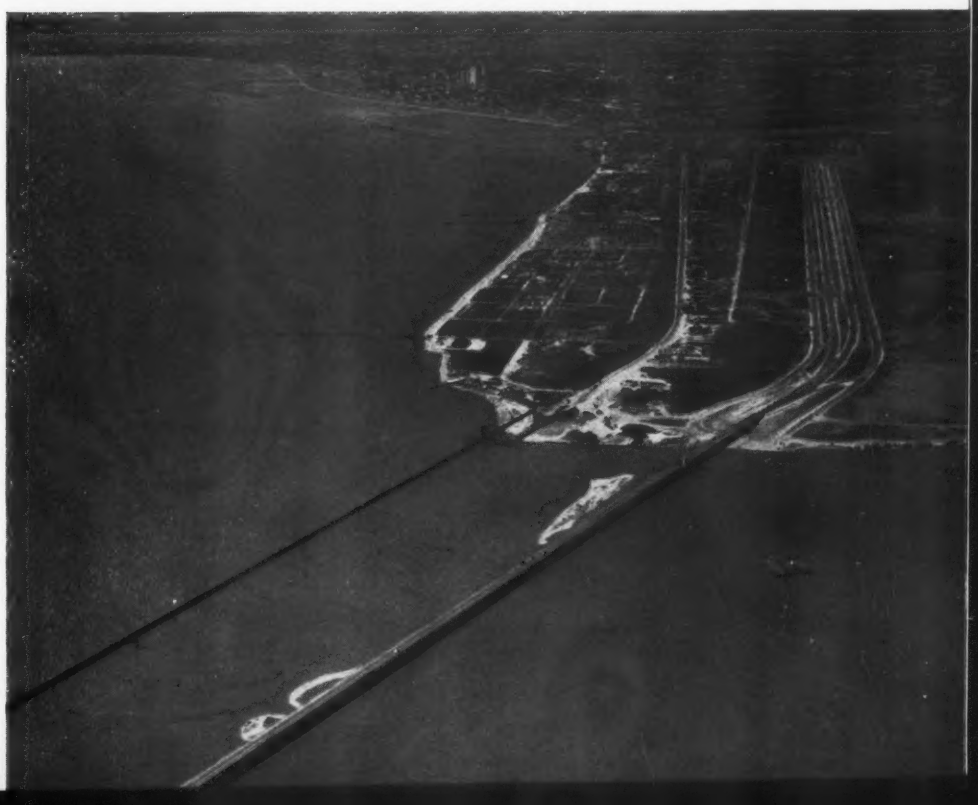
The Appian Way was one of the marvels of its age, and Roman historians proudly recorded the details of its construction. It was the first road so honored, and doubtless deserved the Roman title: *longarum regina viarum*. the queen of long distance roads.

In Texas a like title might well be

Snaking sinuously from Houston's southwest section into town, newly widened Buffalo Drive keeps heavy traffic flowing smoothly. Curb divides opposite lanes.

given the recently opened Gulf Freeway, 50-mile super road between Houston and Galveston. Though not the first divided lane expressway in Texas, the $28 million "Queen" is the state's longest. It is also the longest toll-free super road built in the nation since World War II. Because of these "firsts," it occupies a place of distinction in the state's system of about 600 miles of rural and urban freeways and expressways.

"But why these expensive super roads here in Texas where the wide open spaces stretch to the horizon?" a Texas tax payer may ask. "Don't two-



Corpus Christi's Nueces Bay causeway pours traffic into a multi-lane expressway that moves it on into downtown section.

La Porte-Reveille Interchange in Houston's East End is the Gulf Freeway's most complicated network. At right, the main airport road leads off. Going under the split roadway is the road connection to La Porte and points east in Harris County.

Central Expressway in Dallas channels a heavy load of passenger automobiles into and out of the downtown

The Gulf Freeway, as aerial photographer sees it, carries almost 100,000 vehicles a day to and from the downtown section of Houston. On both sides of the expressway, exit and entry ramps lead to service roads into residential and business sections.

lane roads meet traffic requirements?"

State highway engineers and others responsible for public safety on the roads respond with a fact-supported "No." They say divided lane expressways and freeways are necessary because: Texas has experienced an enormous increase in vehicles in the last 10 years; because there has been a pronounced population shift to the state's urban centers; and because safety and economy demand this kind of construction.

heavy load of busses, other commercial vehicles, and downtown section. Here the six-lane expressway winds through a beautifully wooded area of the city. Convenient exit and entry ramps give easy access to residential areas all along the road's length. Road is well lighted.

In 1942, they point out, 1.7 million vehicles were registered in Texas; in 1952 the number is 3.4 million. Exactly twice as many. These engineers further estimate that with 10 vehicles to every 26 Texans, travel over Texas highways averages about 81 million miles daily.

Much of this high mileage is clicked off near or within the state's main population centers. That is because more Texans than ever before have moved to these centers. Census figures show that from 1940 to 1950 the state's urban population increased from a little under three million to 4,834,000. Add to that the tendency of more and more people to want to live on the outskirts of cities where they work, and the engineers say you have the answer to why traffic congestion has become a problem in most of our Texas cities.

With the congestion, of course, has come the problem of increasing automobile and truck accidents. The Honorable E. H. Thornton, Chairman of the Texas Highway Commission, is the authority for these terrifying 1951 totals: "Automobile accidents on the public roads of Texas claimed 2,500 lives, injured 68,000 people, and caused property damage in excess of $100 million."

Highway engineers know that engineering and road planning alone cannot eliminate accidents. They fully recognize the part played by mechanical failure, human error, weather, and other uncontrollable factors. They are

Over-and underpass on the Central Expressway in Dallas shows these major traffic arteries may be attractive as well as useful.

Steady current of traffic on the urban section of the Gulf Freeway in mid-afternoon shows load carried by this new expressway.

quick to explain, however, that engineering can eliminate some of the major hazards to life and limb, and they quote expressway experience figures to back their contention.

"On the Houston urban section there have been four fatal accidents while cars and trucks were rolling up 252 million vehicle miles," writes W. J. Van London, the Highway Department's engineer-manager for the Houston Urban Expressway System. "This is 1.6 fatalities per 100 million miles as compared to the national rate of 7.5 for all types of highways."

In San Antonio and Dallas the safety record on expressways is even better.

Safety and greater service to the constantly increasing flow of traffic, then, are the reasons for the increase in divided-lane highways in and around the major population centers. In 1942 the total Texas mileage of such roads was 65.7; today 600 miles have been completed or committed.

A look at Humble's 1952 Texas road map shows that most of this mileage leads into or passes through Dallas, Fort Worth, Waco, Wichita Falls, Corpus Christi, San Antonio, Houston, and Galveston. In many of the less populous communities, four-lane bypasses skirt business sections to keep inter city traffic from becoming snarled in local traffic.

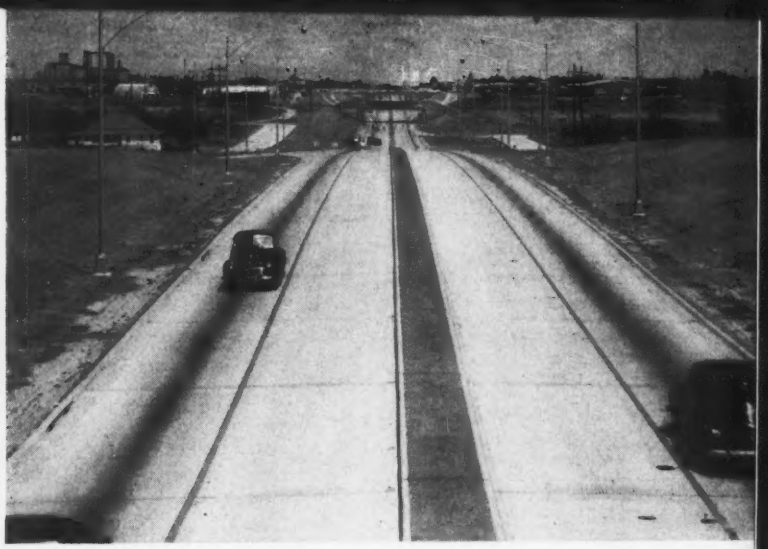
Many a Texan hurrying across the state has swerved around a town on one of these by-passes and uttered a silent "thanks" to someone. Probably about as many have wondered how that someone determines where a divided multi-lane road is needed.

Competent traffic engineers of Texas and the nation have concluded as a result of surveys that when a road carries more than 4,000 vehicles a day, safety and economy call for additional lanes. Traffic counts show that the urban section of the Gulf Freeway approaches 100,000 vehicles per day in the summer months; that an estimated 12,000 per day will use the section between the city limits of Houston and Galveston. These figures indicate forcefully the need for the Gulf Freeway. But there are 3,000 more miles in the Texas trunk highway system, according to Chairman Thornton, which daily carry more than 4,000 vehicles, indicating a need for many more miles of super highways.

Maybe the rapid growth of the state's present system of paved roads casts the pattern for the future. When cars were few and a 50-mile trip was a major undertaking, paved highway mileage was very limited. But as cars, trucks, and busses increased to put the nation on wheels, highways were built for their use. If the need continues to increase, as it has in the past three decades, perhaps tomorrow may see the development in Texas of a master network of superhighways designed to save lives, time, and money.

In Austin, this expressway connects with another near the capital's busy airport. Crossings are level with regular roadways; center section is sunk below ground level.

Sign on lamp post at right points out nearest exit road to the hurrying lane of traffic. Houston's skyline rises in background.



At Fort Worth, multi-lane expressways lead into town from all directions. This one is coming in from the south on U. S. 81.

Mud flats are like wet desert, stretching barren on all sides to the horizon.

EXPLORING ON THE MUD FLATS

Oil hunters devise special vehicles to transport crews and their equipment

PROPER transportation has always been a pressing problem in the search for oil. All sorts of unusual vehicles have come out of the need to move exploration crews and their equipment over all kinds of terrain—each type of terrain demanding its particular kind of vehicle.

The transportation problem, rather easily solved in flat and dry upland areas where no mountains or broken country impede progress, becomes much more difficult in swamps and marshes. For these areas, wide-wheeled "marsh buggies" — awkward looking, but efficient—were built to carry men and their equipment over weed-filled shallows and marshy bogs. Helicopters later proved their worth in the same kind of country. In deep water offshore in the Gulf of Mexico, it was an expensive business to adapt all sorts of seagoing craft to the work of oil exploration.

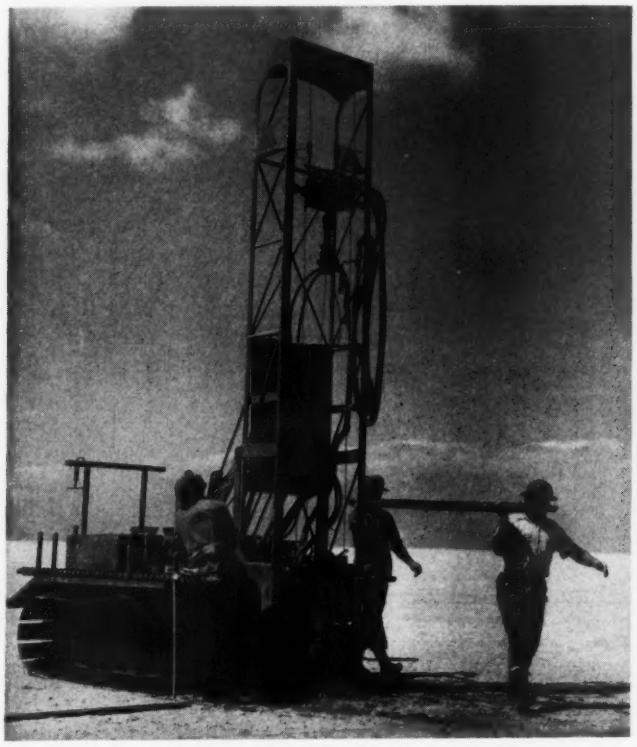
But still another type of terrain in the past few years brought up newer problems of transportation for oil hunters. This is an area that might be described as the mud flats along the Texas coastline. These smooth surfaced, gently sloping areas are sometimes perfectly dry and sometimes covered with sheets of wind-driven water. It is a flat, muddy, watery wasteland where distances are deceiving. Here the eye sweeps all around the horizon without the relief of hill or tree or any kind of vegetation.

When the time came to go into these

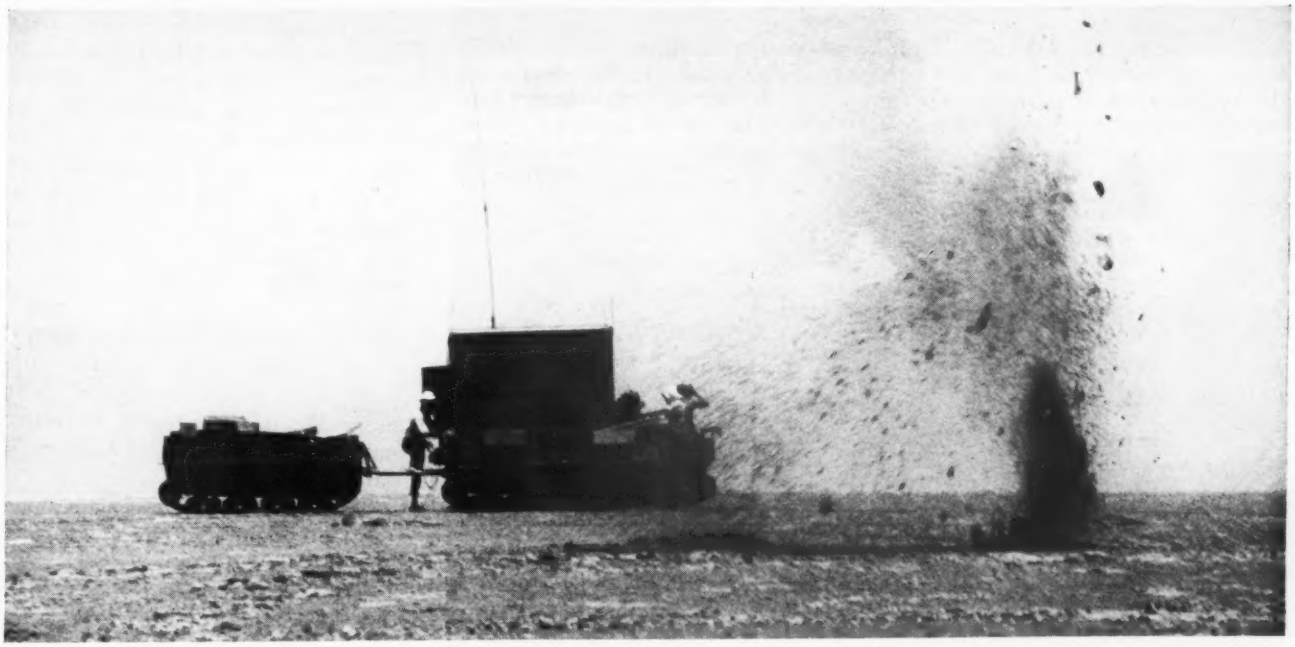
areas to search for oil, Humble tried every kind of vehicle at its disposal. It tried the conventional swamp buggies, but these failed to measure up to the demands of the job. One of the old, original slat-wheeled "Model-A" marsh buggies almost proved successful, but not quite. It was designed for grassy swamps, not for mud flats. Clearly, this was an area that demanded its own kind of vehicles. Humble set about to devise some to fit the job.

A start was made when the Company found three "weasels" rusting in a Corpus Christi junkyard. Weasels are amphibian vehicles with tractor-like treads; they were designed for the armed forces during World War II for use in water and snow. Working in the latter element, they earned the name of *snowmobile.*

From the three junked weasels, enough parts were salvaged to build one good, workable vehicle. Put to trial



Drilling shot-holes for explosives on the mud flats requires different transportation for rig than in other kinds of country, though principle is the same. Booted against the mud, man at right prepares to lower charge of explosive into new hole.



Geyser of mud erupts as the charge is set off from recording truck in the background. The seismogram, or record, will be developed in truck's laboratory. Pulling the recording truck is wartime "weasel" converted by Humble for use on mud flats.

Converted weasel, its treads half buried in the mud, hauls a shot-hole drilling crew out to a location. Drilling rig is mounted on a raft supported by pontoons.

Airboat, the *Golly Bum,* skates merrily along on nothing but a few inches of water. Flat-bottomed airboat moves crewmen from job to job, goes up to 40 miles per hour. Below, supplies of explosives for seismic shots are loaded aboard a smaller airboat.

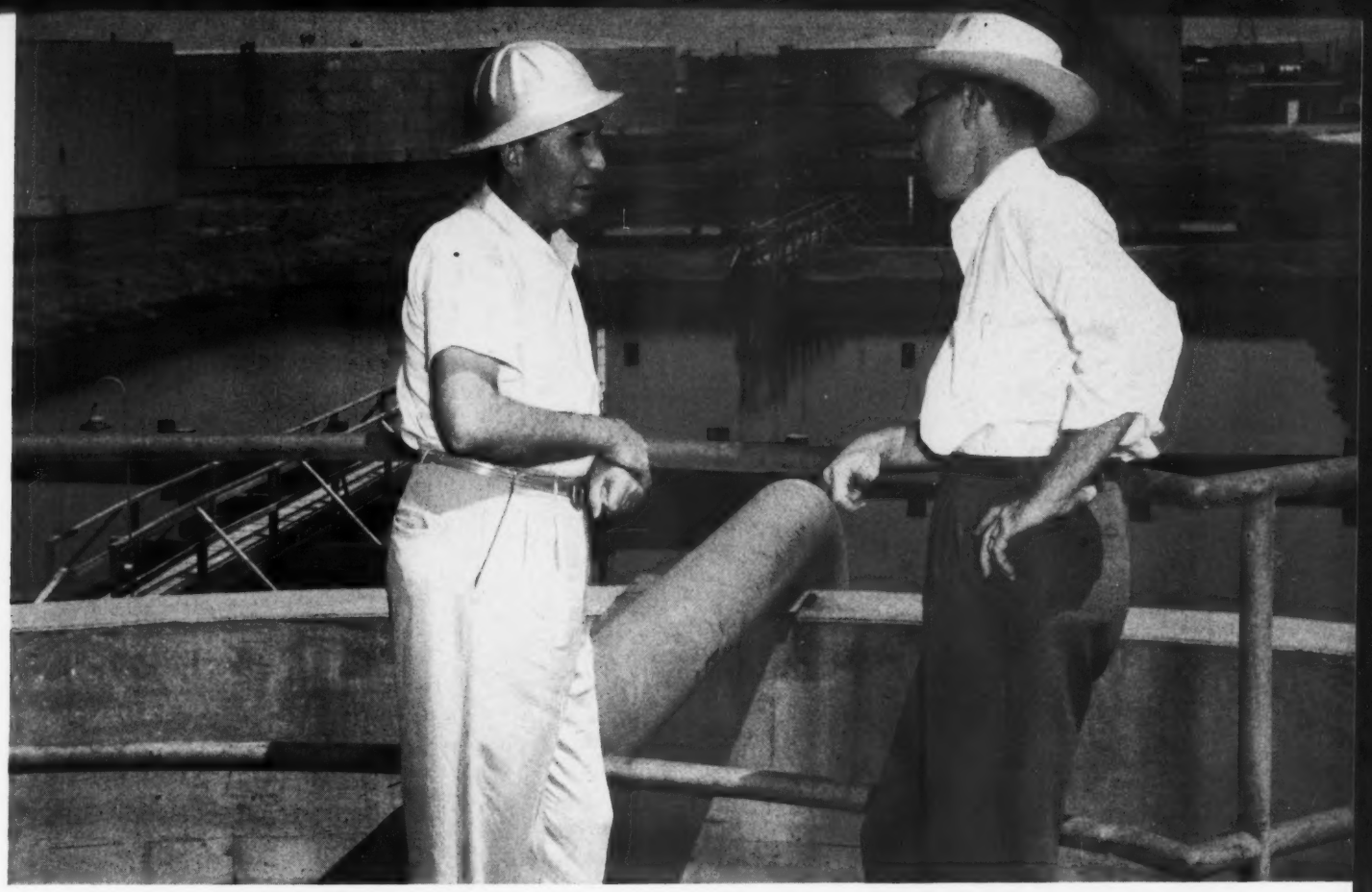
and tests along the mud flats, the weasel proved itself to be a versatile workhorse in an area where other forms of transportation had failed. Humble had what it wanted, and a search began for more weasels to join the "mud flats fleet."

Other vehicles were more or less home-made to fit the job. Helping the weasels as carriers for material and supplies were small rafts mounted on short, shallow pontoons. Airboats, fitted with broad, flat bottoms and powered by airplane propellers, were designed to move crews from place to place. With their propellers mounted at the stern, these airboats can zip a crew of 10 to 15 men along at a speed of 30 to 40 miles an hour in only a few inches of water. Over short stretches between patches of water, these strange-looking craft can keep going if the sand or mud is wet enough.

In this unusual country, in warm weather, it is not unusual for crews to splash barefooted about their work, pants legs rolled to the knee. But while their surroundings are strange, their work goes on just as it would anywhere, in any kind of country. In making seismic surveys, there is the work of drilling shot-holes, loading explosives for the shots, laying lines from the shot-holes to the recording truck, placing geophones or pick-ups, setting off the charges, and reading the results of the shot on seismograms developed on the spot in the recording truck. This work is the same miles out in the mud flats as it is on an inland plain—only the locale is different.

As exploration progressed on the mud flats, Humble kept steadily at the task of improving its vehicles designed for that work. Ways were developed to make the boats and rafts and weasels more efficient. More recently, there has been a shift from the service-type weasel to tractors with higher-standing treads. This makes it easier to operate in areas where winds may raise the water level several inches on short notice. Weasels lie lower in the water and are more exposed to changes in water level.

Pictures on these pages tell a graphic story of Humble's efforts to meet an unusual problem with an unusual solution. It is as if Company people had said, in so many words: "Show us where you think there may be oil, and we will find some way to get to it."



Dr. W. A. Cunningham, left, Professor of Chemical Engineering at The University of Texas, takes time out from his work at the Effluent Filtration Unit at Baytown Refinery to talk over a problem with Charles Van Berg, of Technical Service.

Professors Spend Summer on Humble Problems

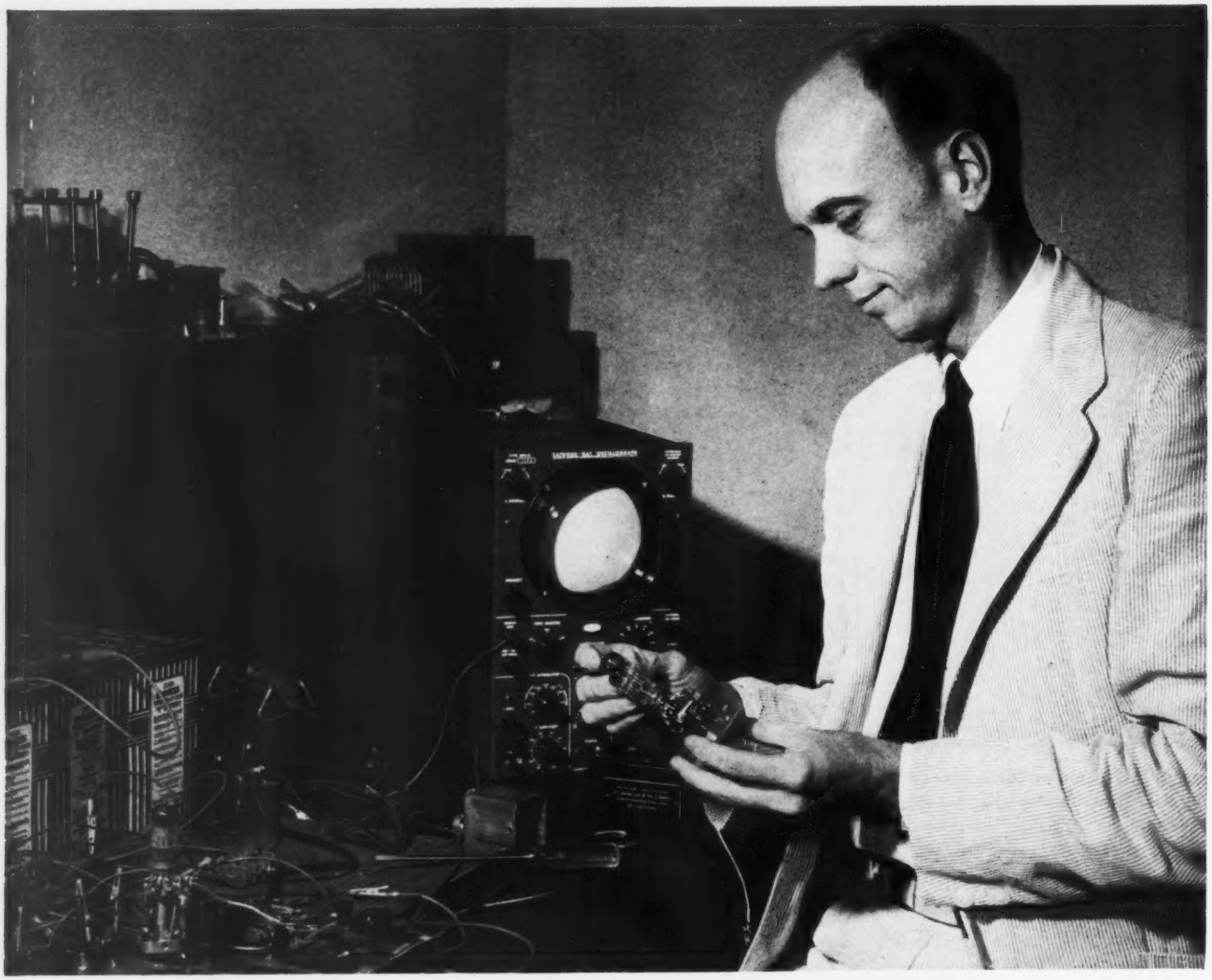
HUMBLE is widening its circle of friends and acquaintances among college professors and administrators. Some educators first learned of Humble through visits and inspection tours of Company operations. Some have taken part in the Humble Lectures in Science for Baytown Refinery personnel. Others consult with Humble on research problems, use equipment made available by the Company, or exchange scientific information for mutual help. Still others help administer the Humble Fellowships in Science and Engineering for graduate students on their campuses.

This summer, however, five college professors are getting an even longer and more complete look at Humble, its work, its problems, and its way of doing things. All are employed for the summer—each working on some problem that follows closely or precisely parallels his work at college.

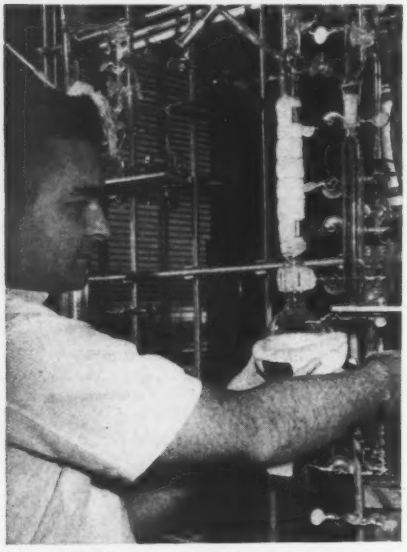
The group so employed includes Dr. W. A. Cunningham, Professor of Chemical Engineering at The University of Texas; Dr. E. S. Lewis, Associate Professor of Chemistry at The Rice Institute; Dr. M. M. Gilkeson, Assistant Professor of Chemical Engineering at Tulane University; Dr. Bernard Ostle, Assistant Professor of Statistics at Iowa State College; and Dr. Carl Wischmeyer, Associate Professor of Electrical Engineering at The Rice Institute.

Professor Cunningham is working on problems of water treatment, water use, and waste disposal at Baytown Refinery. One of his projects is concerned with more efficient operation of Baytown's new Effluent Filtration Unit, where wastes are treated and cleansed before they are disposed of. This unit's job is to make plant wastes as good as, or better than, water in the Houston Ship Channel into which the wastes are discharged. Dr. Cunningham is also working on ways to cut down on corrosion and scale caused by water in plant equipment, as well as to conserve water used by the Baytown plants.

Professor Gilkeson is working on the design of a reactor to study the rate of chemical reaction in the hydro-



Dr. Carl Wischmeyer, Associate Professor of Electrical Engineering at The Rice Institute, at work in Humble's geophysics research laboratory. Dr. Wischmeyer is working on a device to extract more usable information from seismic records.



Dr. E. S. Lewis, Associate Professor of Chemistry at The Rice Institute, working on research problems at Baytown.

forming process. It was hydroforming that gave the Allies so much synthetic toluene during World War II—toluene from oil for bombs and other explosives. The process in peacetime has been converted to the manufacture of solvents and high quality gasolines. It also provides a good source of material for the petrochemical industry. Paraxylene, soon to be manufactured by Humble for use in Dacron, the new synthetic fiber, is a hydroformed product. In addition to design work on the reactor, Dr. Gilkeson is assembling all known data on the hydroforming reaction as ground work for present and future studies.

Professor Lewis, son of the late, internationally famous Dr. G. N. Lewis of the University of California, is studying the rate of alkylation reaction. Alkylate is the backbone of high octane aviation gasoline, and its chemical reaction during manufacture is a highly complicated process that needs better understanding. Humble hopes that systematic studies of the alkylation reaction may lead to higher yields and a better quality product.

Since modern scientific research involves a great deal of mathematical formulae, it is not difficult to understand why a professor of statistics has spent the summer at Baytown working on research problems. Dr. Ostle is applying the principles of statistical experimental design in formulating research programs.

Professor Wischmeyer is working in the Houston Office geophysical research laboratories, attempting to develop a device that will extract more usable information from seismic records. It is easy to decipher some

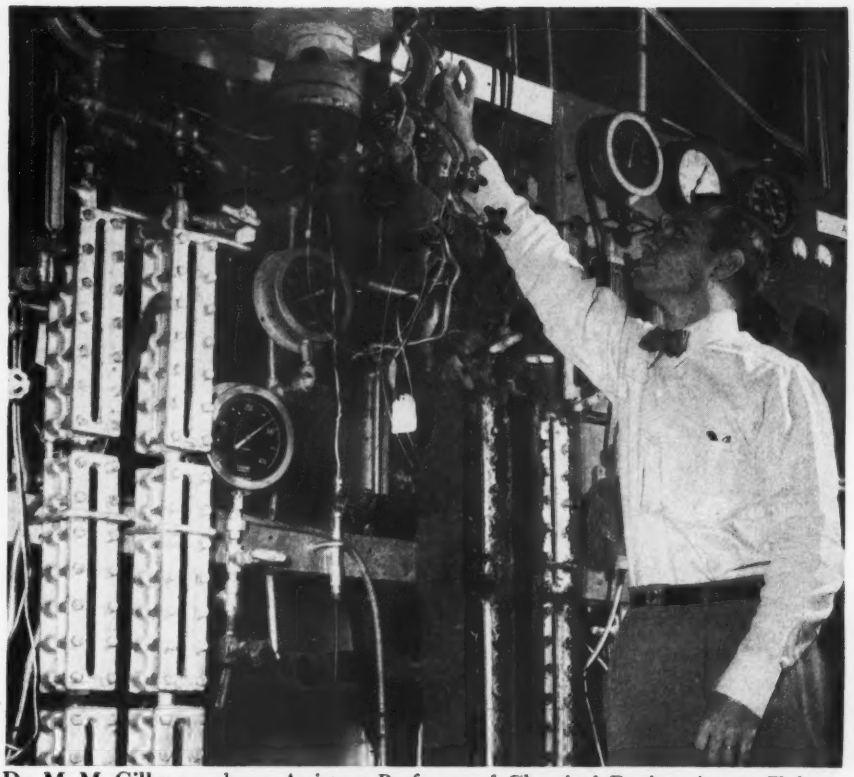
records of shots made in "good" areas while searching for oil. But the job of reading and interpreting those records is much more difficult and detailed in other areas where underground structures are not so well defined. Dr. Wischmeyer is working on a modified recording device which will eliminate some of the less important data normally recorded, and give a sort of streamlined, or *"Reader's Digest"* version of the important data.

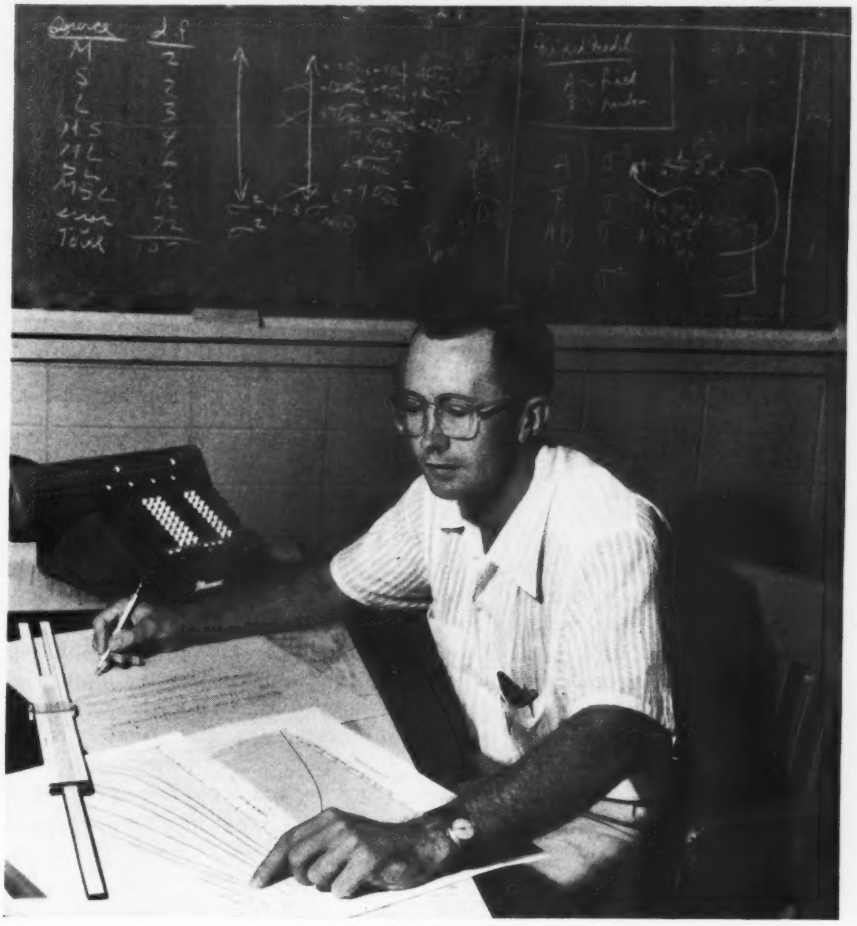
It is interesting to record the attitudes of some of the professors toward this summer work. As Dr. Lewis put it, "Chemistry is chemistry, whether in the college laboratory or in an oil refinery. My work here this summer is closely connected with work I am carrying on with my graduate students. I am not working on applied chemistry, but on problems of fundamental research. You might call it a leap from theory to theory, rather than from theory to practice."

Dr. Cunningham's Baytown experience is almost exactly the opposite. "I welcome this change of pace from theory to practice," he explained of his work on water problems. "It gives me an opportunity to see in practice some of the things I have been teaching. It will definitely react to the benefit of my students; I shall be better equipped to give them what they need." The professor paused for a moment, then added, with a twinkle: "My students had better be prepared to work out some problems on refinery water use and waste disposal during the coming year. There will be plenty for them to do!"

Dr. Gilkeson took time out from his laboratory work to comment: "I am most impressed by the friendly attitude and the cooperation of my fellow workers here. The working conditions are splendid; the surroundings are conducive to good work. Undoubtedly, the high morale of Baytown employees has a direct relation to the quality of work turned out here."

All in all, it has been a most satisfactory arrangement—one that has led to better understanding on both sides. The working professors expect to carry back to school with them a better understanding of what industry wants from technical graduates. Humble, for its part, has benefited from fresh viewpoints and new approaches to possible solutions of industrial problems.





Dr. M. M. Gilkeson, above, Assistant Professor of Chemical Engineering at Tulane, is checking Baytown equipment used to study alkylation reaction. Below, Dr. Bernard Ostle, Assistant Professor of Statistics at Iowa State College, works out a problem.

Curving counter, wide enough for maps, is feature of new Touring Service office. Relief map of Texas is set into brick wall.

NEW QUARTERS FOR HUMBLE TOURING SERVICE

Exterior view of new Touring Service office shows inviting all-glass front. This is corner of renovated Humble Building Annex.

THE Humble Touring Service has moved into new quarters on the first-floor corner of the recently renovated Humble Building Annex at Main Street and Dallas Avenue in downtown Houston. Service to tourists from this new location began the second week in August.

Since its beginning in 1933, the Touring Service had been located next to the Main Street entrance of the Humble Building. Continued demand for expanded service and an increase in staff to take care of that demand made it necessary for the Touring Service to move into larger quarters.

Pink brick walls and walnut-finished paneling are used for the modern interior of the new offices. Furniture is in matching walnut finish. On the south wall, and attracting much tourist attention, is a large floor-to-ceiling relief map of Texas showing topographic features and all major highways.

Maps and vacation folders are kept in cabinets and under the counter in the front office, giving the visitor an impression of quiet, uncluttered beauty. In this office, travel experts mark maps, give travel advice, and answer questions for those who call in person.

In the back are headquarters for W. E. Hill, head of the Touring Service, and his staff who map vacations for patrons who write or telephone their requests for help.

On opening day, 641 persons asked the Touring Service for travel help and other information.

Ten employees retire

Average more than 29 years of service; two have been with Company more than 32 years

TEN long-time employees of the Humble Companies have retired since these columns last reported. Their combined credited time with Humble represents 291 years of service. All but two of the employees have 27 or more years' service. Jesse B. Kerr, mechanic first in the Houston Garage, and George B. Ethington, helper at Baytown Refinery, have the longest periods of service among this group of new annuitants, each having more than 32 years with Humble.

Humble Pipe Line Company—John W. Hinds, telegraph operator at Satsuma Station, retired June 20 after more than 30 years' service. Mr. Hinds started with Humble as a telegraph operator and later worked as gauger, timekeeper, oiler, material clerk, engineer, oil dispatcher, deliveryman, district gauger, chief engineer, field clerk, and stock gauger. At the time of his retirement he was president of the Employees Federation of Humble Pipe Line Company Southern Division. He plans to spend more time at his hobbies, writing short stories and woodworking.

Louis H. Johnson, general foreman in the Tomball Office, retired July 28 after more than 29 years' service. He joined Humble at Camp No. 4 as a laborer and later worked as a truck driver, powderman, subforeman, assistant foreman, stabber, ditch foreman, gauger, inspector, connection foreman, and lay foreman.

Production Department—Otis Buchanan, lease pumper-gauger at London, retired June 2 after almost 31 years' service. Mr. Buchanan started to work for Humble as a roustabout at Burkburnett. Later he worked at Iowa Park, Luling, and Arp; he moved to London in 1932. His chief interests include gardening and raising flowers and chickens. He will live near Kilgore.

Jesse B. Kerr, mechanic first in the Houston Garage, retired August 12 after more than 32 years' service. He was employed at the Main Street Garage as an auto mechanic; all of his service with the Company has been at the garage. He owns his home in Houston, where he will continue to live. During retirement, however, he plans to travel some.

James J. Spillers, Sr., compressor plant operator and gauger at Goose Creek, retired July 21 after more than 31 years' service. He began work with Humble as a roustabout at Goose Creek; later he worked at Barbers Hill and Baytown Refinery. He plans to buy a home near Anahuac, Texas, raise a garden, hogs, and chickens, and do some fishing.

Baytown Refinery—George B. Ethington, helper, retired June 19 after more than 32 years' service. All of Mr. Ethington's service has been in the Pipe Department at the Refinery. About 31 years ago while he worked on a line in a ditch, its bank caved in and covered him. Presence of mind enabled Mr. Ethington to dive in a bell hole where he remained until fellow workers uncovered him. On retirement, he will raise a garden and take care of his home.

Ganie Huggins, welder first, retired July 1 after more than 30 years' service. Except for about three years he spent at McCamey, Mr. Huggins has worked at Baytown Refinery mostly in the capacity of a welder. His special interests include hunting and freshwater fishing. He will take care of an 18 acre farm at Jacksonville, Texas during retirement.

Eugene W. McLean, helper third, retired July 4 after almost 24 years' service. All of his service with Humble was spent at the Refinery in the Pipe and Distillation Departments. He likes hunting as a hobby. During retirement he plans to improve 60 acres of land he owns near Picketts Bayou.

Charles Mills, laborer, retired June 16 after almost 27 years' service. He has held various jobs in the Labor Department and at the Docks. His special interest is farming.

Thomas F. Wells, helper third, retired July 7 after almost 25 years' service. Except for a short time he worked in the Pipe Department, all of his service has been in the Distillation Department of the Refinery. Mr. Wells is a gardener and fresh-water fisherman.

SINCE the last issue of THE HUMBLE WAY, eleven active employees and three annuitants have died.

Active employees who have died are: Luther A. Allison, 50, rotary driller at Stratton District, on July 20; Cyril T. Bolleter, 53, wire chief in Communications & Electrical Department in the Houston Office, on June 28; Mrs. Edna C. Davis, 47, senior accounting clerk of Production Accounting in the Houston Office, on August 8; William C. Dunahoe, 51, operator at Baytown Refinery SO2 Plant, on June 13; Jake L. Guarino, 39, production foreman in Specialty Products Manufacturing in Houston, on July 9; James C. Johnson, 45, research geophysicist in Exploration-Geophysics in the Houston Office, on August 12; Percy Shipman, 45, painter in Building Maintenance in the Houston Office, on June 21; Robert C. Smith, 23, reproduction operator in Stationery, Printing, and Reproduction in the Houston Office, on July 26; Thomas A. Stevens, 63, gas plant repairman first at London Gas Plant, on August 9; Jere C. Showalter, 55, research specialist at Baytown Refinery, on August 9; Walter D. Stovall, 42, farm boss at Sugar Valley District, on June 22.

Annuitants: John P. Atkinson, 74, field clerk at Webster Station before his retirement, died on August 2; John L. Hamblet, 67, truck dispatcher at Houston Bulk Station before his retirement, died on July 27; William P. Slaughter, 59, oiler at Comyn Station before his retirement, died June 11.

By the way...

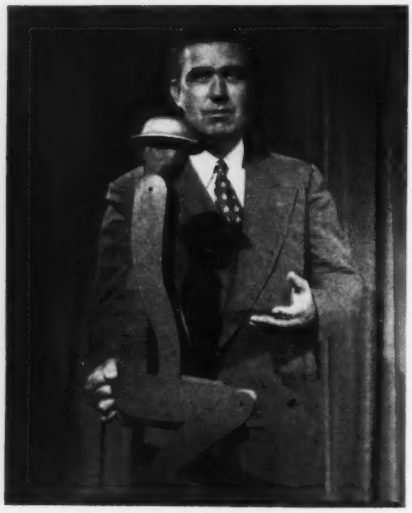
HINES H. BAKER ACCEPTS COMMITTEE ASSIGNMENT

● Mr. Hines H. Baker, President of Humble Oil & Refining Company, has just been named to the National Petroleum Council's 26-man Committee on Submerged Lands Productive Capacity. The Committee is composed of leading oil executives throughout the nation. Its work will be to study and report on the oil and gas prospects of offshore submerged lands on the basis of technological aspects only, without regard to ownership or title.

Mr. Walter S. Hallanan, NPC Chairman, said the study was requested by the Oil and Gas Division of the Department of the Interior.

RIGHT AND WRONG WAYS TO LIFT

Wrong Way



Right Way

● One of our readers, after looking over the article "The Engineer and the Model" in the May-June issue, had a good point to make.

With the article was a picture showing a model workman lifting an object the wrong way, putting all the strain on his back. "Why not show the *right* way?" she asked.

A good idea. Here we show both ways to lift an object. The right way is to keep the spine straight. This puts strain where it belongs—on the leg muscles.

THE FRONT COVER

● Before painting the cover for this issue, Artist E. M. Schiwetz drove leisurely up and down the new Gulf Freeway in search of the scene that would most effectively illustrate the utility and beauty of this new expressway.

He settled on the master interchange scene in the east end of Houston. Here the main course of the Freeway is divided and a series of service roads, underpasses, and overpasses make a pattern that interested Mr. Schiwetz. Against the backdrop of the Houston skyline, the steady stream of through and diverted traffic gives life to the great highway.

The HUMBLE WAY

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Published every other month for employees and stockholders

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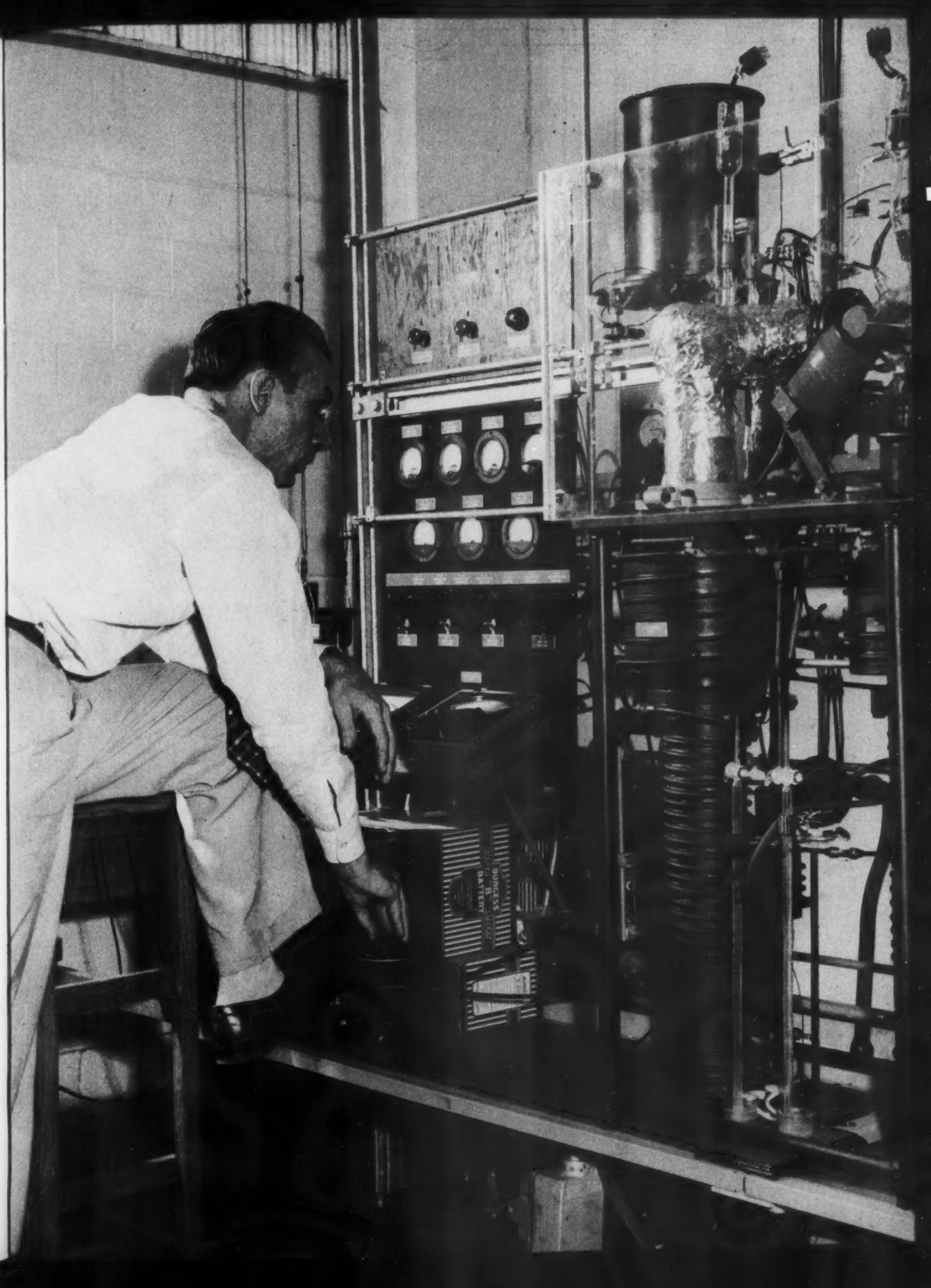
Research scientist at Baytown Refinery prepares for trial tests of a newly-built experimental device called an ion-bombardment machine.



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hine.

On Football Day...

Go the Humble Way

This football season, for the 19th consecutive year, Humble will continue its public service of broadcasting Southwest Conference games to a steadily growing audience of football fans throughout Texas.

While millions listen to the radio broadcasts, thousands of others will enjoy Humble telecasts of big games. Live telecasts of certain games will be made as permitted by the Conference. Every major game will be telecast in film over one or more television stations on the Sundays following the games. And a round-up of football highlights will be shown on Monday evenings as part of Humble's television program, "This Week in Texas."

HUMBLE OIL & REFINING CO.